LITTLE BLUE BOOK NO. 728
Edited by E. Haldeman-Julius

Life Among The Bees

Vance Randolph

Drawings by Peter Quinn

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LIFE AMONG THE BEES

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LIFE AMONG THE BEES

CHAPTER I

BOOKS ABOUT BEES

The Ancient Writers

The common honeybee (Apis mellifica) is of Asiatic origin, and was well known about the eastern end of the Mediterranean at least a thousand years before the beginning of the Christian era. Many of the literateurs of antiquity—Aristotle, Cato, Varro, Pliny, Columella, Palladius—were interested in bees and beekeepers; there are tales also of the lost writings of Phyliscus, and the vast learning of Aristomachus, who, according to Cicero, loitered among his beehives for fifty-eight years. On the whole, however, the ancients knew very little about the habits of bees, and such knowledge as they did have may be found epitomized in the fourth book of Virgil's Georgics.

The Silence of Medieval Europe

Bees were introduced into Europe as a part of the Roman culture, and honey was, except for fruit sugars, the only sweet known to medieval Europe, but the scholars of the day were quite content to quote Aristotle on the subject, and the actual study of the "honey-fly" was left to farmers who read little and wrote nothing.

From Swammerdam to Dzierzon

The first really scientific study of the bee was that of Swammerdam, a Dutch scientist who lived in the seventeenth century. Swammerdam was the first man to make any creditable dissections, and he discovered that the so-called "king bee" was really a female. Next came a Frenchman named Réaumur, who contrived a glass observation hive, investigated the complex phenomena known as swarming, and exploded many venerable fallacies. Later researches were those of Charles Bonnet and Schirach, who solved the enigma of the royal egg, and made several valuable minor contributions. One of the best books ever written about bees was published at Geneva, in 1789, by a blind man named Huber. This Huber, despite his tremendous handicap, repeated many of Réaumur's experiments, carried out a great number of original researches, and compiled a marvelously lucid summary of the entire literature of the subject. In 1845 one Dzierzon, a German clergyman, discovered the principal facts of parthenogenetic reproduction in bees, and laid the foundation for all later scientific work in this field.

Books for Beekeepers

Modern books about bees fall into three general classes: there are the practical works on apiculture, the scientific studies of bee structure and function, and a third group of books which may, in the absence of a better term, be designated as imaginative or poetic.

The practical books are written by and for beekeepers, whose sole business is apiculture and whose chief interest is the increased production of honey. Although the honeybee is not native to America (the first German bees were brought to New England in 1638, and the first Italians imported about 1860) commercial beekeeping is primarily an American institution, and there are no better practical books anywhere than those of Langstroth, Quinby, Miller, Demuth and Root.

Scientific Research

The scientific writings are the result of elaborate researches, carried out in the main by university professors, men who have no particular interest in honey production, and who are not trying to make money out of the bee business. Comparatively few of these investigations are of any immediate value to the apiculturist, and the solid citizen may and does inquire why such studies should be pursued at all. However, we must remember that some people take pleasure in scientific work, precisely as others do in music or literature; nobody thinks of asking whether these latter pursuits have any practical utility, because the value of pleasure is obvious enough; the same toleration might well be extended to the futilities of science. Then, too, one can never be quite certain that one of these priests of science is *not* just on the point of making a valuable discovery—valuable, that is, in the sense that some practical man can make money out of it. Six hundred and five experiments may conceivably come to naught, while the six hundred and sixth proves an unqualified success. Most of the best scientific work has been done in Germany by such men as Bethe, Buttel-Reepen, Zander, von Siebold, Buchner, and Gunderach. However, the studies of Forel, Plateau and others in France, and the papers of McIndoo, Snodgrass and Phillips in America, are all examples of this class of writing.

Imaginative Literature

The books of the third class are imaginative and fanciful, dealing mainly with the romantic aspects of the communal life, and with certain fascinating analogies that may be drawn between bee behavior and the social responses of human beings. Some of these works, as for example the children's tales of the "Bed-time Story" type, are frankly fiction—human conversations put directly into the bees' mouths, and all that sort of thing—while others pretend to a certain degree of scientific accuracy. Many of these latter are vastly interesting; for example, judged solely on its literary merits, Maeterlinck's "Life of the Bee" is probably the best bee-book ever written, but the student who really wants facts about *Apis mellifica* will do well to seek them elsewhere.

CHAPTER II

THE BEE'S BODY

The body of the honey-bee is divided by constrictions into three parts: the head, the thorax, and the abdomen. The head carries the eyes, antennae, and mouth parts; the thorax bears the legs and wings; and the abdomen the wax-plates and the sting.

The Head, Eyes and Mouth-Parts

The head of the worker bee is roughly triangular with the apex at the bottom. Three small simple eyes or *ocelli* are set in the top of the head, two large *compound* eyes round out the upper corners, two *antennae* spring from the middle of the face, and the *mouth parts* are situated at the bottom. The antennae serve as "feelers," and are believed to contain the principal organs of smell; each is composed of a series of joints, the one nearest the head being the largest. Below the antennae there is a flap-like upper lip called the *labrum.* On the lower surface of the labrum is a soft tissue known as the *epipharynx*, which bears the organs of taste. Below the labrum are the jaws or *mandibles*, which work sidewise instead of up and down in a median plane, as our jaws do. The worker's mandibles are spoon-shaped and blunt, while those of the queen and drone are serrated and provided with sharp points. The mandibles of the queen and drone are similar to those of other Hymenoptera, but the jaws of the worker show a high degree of specialization. On each mandible is the opening of a gland—very small in the case of the drone—which is thought to secrete a liquid used in softening wax.

Behind the mandibles is a second pair of jaws called *maxillae*, each consisting of three parts: a basal stalk known as the *cardo*, a plate-like *stipes*, and a wide flat blade called the *galea*. The galea bears a little knob which corresponds to the *maxillary palpus* of other insects. Below the maxillae is the *labium* or lower lip, consisting of the *mentum*, the central tongue-like *glossa*, and the two jointed *labial palpi*. The parts of the maxillae and labium are not distinct as in many other insects, but are combined to form the *proboscis*, which is usually folded back beneath the head. In sucking up honey or syrup the bee unfolds the maxillae and labium and presses the parts together so as to form a tube between them. The labium moves up and down between the maxillae, and the liquid is pumped into the mouth. In sucking up very small drops of nectar the glossa is brought into play, the lighter fluid being drawn up a very fine ventral groove by capillary attraction.

The Thorax, Wings and Legs

The thorax carries two systems of locomotive organs: the wings and the legs. The wings are four in number, but the hind wings are small and are attached by a series of little hooks to the latter edge of the front wings, so that the four are practically converted into two. In flight all four wings move forward and backward as well as up and down, in such a fashion that the tips describe a figure 8 in a sort of propeller-like motion. The wings are moved by four sets of muscles; the forward and backward movements are produced by small muscles acting directly upon the bases of the wings, but the vertical motion is a result of the contraction of very large and powerful muscles, which affect the wings only indirectly by changing the shape of the thorax. The hind wings have no important muscles of their own, but are carried along by the powerful thoracic muscles which operate the front wings. All six legs are used in walking, and each is adapted for other special functions beside: the first pair is provided with *antennae-cleaners*, while the second is fitted with long *spurs* used in emptying the great *pollen-baskets* with which the third pair is equipped. The so-called *wax-shears*

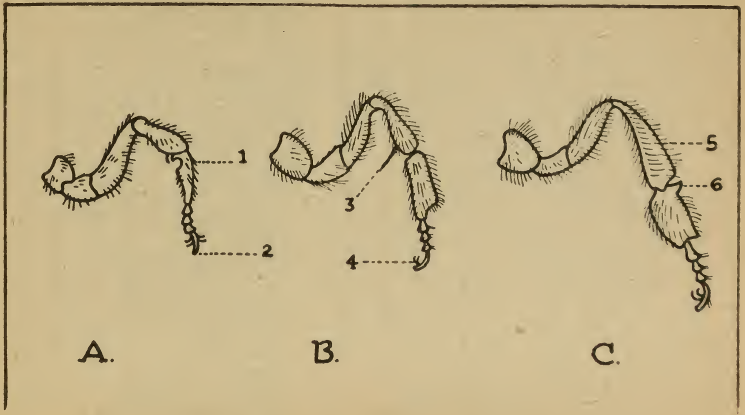

Fig. 1.—Legs of a Worker. A. Front leg: 1, antenna-cleaner; 2, empodium, sticky pad between claws for walking on smooth surfaces. B. Middle leg: 3, spur used in unloading pollen-baskets; 4, tarsal claws. C. Hind leg: 5, corbicula or pollen-basket; 6, the so-called wax shears. (Adapted from Snodgrass.)

on the hind legs have been recently shown to be used in packing pollen into the baskets, and have nothing to do with wax manipulation. The last or tarsal joint of each leg carries a pair of terminal *claws*, by means of which the bee clings to rough objects, while between the claw is the sticky *empodium* which is lowered and used in walking upon smooth surfaces like glass The thorax of the bee is not quite comparable to the thorax of a butterfly or a grasshopper, because it includes the *propodium*, a segment which is in most insects distinctly a part of the abdomen.

The Abdomen, Wax-Plates and Sting

The abdomen bears no conspicuous appendages corresponding to those of the head and thorax, but carries the *wax-plates* and the *sting*. The wax-plates are eight in number, two on each of the last four visible segments of the abdomen. The liquid secreted by glands in these plates hardens into wax upon exposure to the air, forming the white scales which are seen upon the ventral side of the abdomen of any worker engaged in building comb. The sting of the worker bee is a very complicated structure, homologous to the ovipositor of other insects. It is usually concealed in a cavity at the end of the abdomen. The shaft of the weapon is composed of a sort of grooved *sheath*. with two barbed *lancets* sliding in the grooves. The upper part of the sheath is expanded into a *bulb*, which communicates with a large bladder-like *poison-sac*. The poison which makes the bee-sting so painful is a mixture of two liquids, one being an acid while the other has an alkaline reaction. The acid poison is secreted by two glands emptying into the poison-sac, and the alkaline poison is the product of other glands connected directly with the bulb. When the sting is used the two liquids are mixed together in the bulb, and, when the sting is used, are forced down the shaft and out at the tip by a sort of force-pump in the bulb itself—there are no muscles in the walls of the poison-sac. Usually the sting cannot be withdrawn from the wound because of the barbed lancets, and the whole structure—poison-sac, muscles, bulb and all—is torn out of the bee's abdomen, so injuring the insect that it dies in a few hours. As long as the sting remains in the wound the muscles operate reflexly, driving the sting further in and pumping more poison, so that beekeepers who happen to be stung hasten to remove the "stinger" as soon as possible. They are careful, too, not to press upon the poison-sac, for this would empty its entire contents into the wound, and cause much more pain than is ordinarily felt. Drone bees are stingless, but the queen's sting is even more deadly than that of the worker, because it is not torn out of the body at the first atack, but may be used again and again.

The Digestive Apparatus

The *alimentary canal*, the principal part of the digestive apparatus, is a tube extending through the entire body from the mouth to the anal opening. Just above the mouth is a slight expansion called the *pharynx*. The thoracic part of the canal is known as the *esophagus*, and connects with the crop or *honey-stomach* in the front part of the abdomen. The stomach proper or *ventriculus* lies just behind the honey-stomach, and is connected with it by a tube called the *proventriculus*. Next comes the *small intestine*, with a bunch of *Malpighian tubules* circling the front end of it. These tubules act as kidneys, removing nitrogenous waste matter from the blood. The last section of the alimentary tract is the *large intestine* or *rectum*, which may be expanded to retain fecal matter for months at a time, as when the bees are confined in winter, for they never defecate in the hive. All of the nectar which a worker bee collects is taken into the honey-stomach, but only a little passes into the stomach proper, where it is digested and absorbed. By far the greater portion is carried to the hive, regurgitated, and stored in the honey-comb.

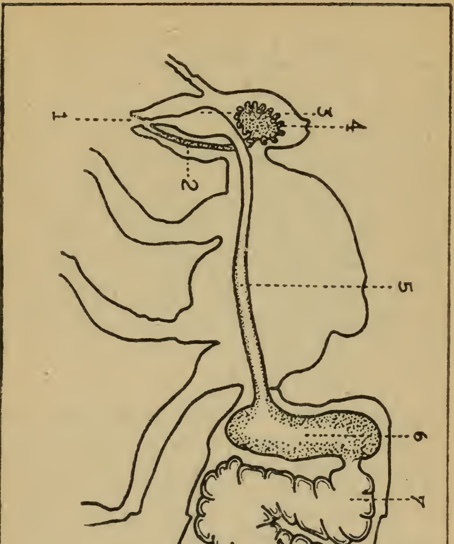

Fig. 2.—The Digestive Tract of Worker. 1, mouth; 2, salivary duct; 3, pharynx; 4 salivary gland; 5, exophagus; 6, crop or honey-stomach; 7, ventriculus or stomach proper; 8, Malpighian tubules; 9, small intestine 10, large intestine or rectum; 11, anus.

The Circulatory System

The circulatory system consists of a simple *heart*—a mere pulsating tube with four swellings in it—located in the front part of the abdomen. There is only one large blood-vessel, a long *aorta* which extends from the heart forward through the thorax into the head. The *blood* is a colorless liquid which percolates about through the entire body cavity, not being confined to any particular vessels. The heart, assisted by two pulsating *diaphragms* in the abdomen, keeps the blood moving, so that it absorbs food from the stomach and intestines, and distributes it to the various parts of the body.

The Respiratory Tract

Insects have no lungs, and the blood does not carry oxygen about as in the higher animals, air being taken into the body and brought into direct contact with the tissues. In the bee there are ten pairs of *spiracles* or breathing-holes along the sides of the body—seven pairs in the abdomen, one in the *propodeum*, and two in the thorax proper. These spiracles are connected with large *air-sacs* reaching from one end of the body to the other, each air-sac being provided with minute branching tubes called *tracheae*, which carry air directly to the various tissues. The carbon dioxid produced in the respiratory changes passes out through the

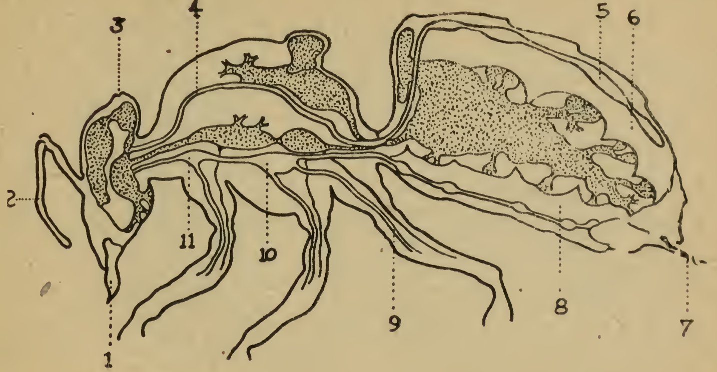

Fig. 3.—Median vertical section of worker's body, showing nervous system, circulatory system, tracheal system, and diaphragms. The tracheal system is shaded throughout. 1, mandible; 2, antenna; 3, ocelli; 4, aorta; 5, heart; 6, dorsal diaphragm; 7, sting; 8, ventral diaphragm; 9, nerve 10 and 11, thoracic ganglia. (Adapted from Snodgrass.)

spiracles, the entire movement of gases being produced by the contraction of the abdominal muscles.

The Nerves and Receptors

The nervous system consists of a row of nerve-masses called *ganglia*, located in a median line along the lower side of the body. These ganglia are made up of nerve-cells, from which long fibers connect with cells in other ganglia, and with muscles and sense-organs in many parts of the body. There are two ganglia in the head: one is called the *brain*, and is connected with the eyes, antennae, and labrum. The other is known as the *subesophageal ganglion*, and gives off nerves to the mandibles, maxillae, and labium, communicating also with the brain and with the first ganglion in the thorax. There are two thoracic ganglia: the first innervates the front legs, while the second controls the wings and the two remaining pairs of legs. The five ganglia in the abdomen serve all of the abdominal segments except the propodeum and the first segment posterior to the constriction. The nervous system of insects is not centralized as in the higher animals such as man, and the brain plays a much less important part. The cutting of the connective which corresponds to the spinal cord in man does not cause immediate death; even if the head is cut off the bee can walk as well as ever.

The organs of *vision* are discussed in the section dealing with the head, but what little is known of the other senses may well be mentioned here. It is generally believed that the organs of *smell* are confined to the antennae, but McIndoo has shown that bees whose antennae are removed still respond to olfactory stimulation, and has located olfactory organs on the legs, at the bases of the wings, and on the sting.

It used to be taken for granted that the pleasant odor attracted bees to flowers, but Forel and his followers think that they are guided chiefly by vision, despite the fact that many inconspicuous blooms are visited. The work of Gates, who showed that bees are attracted by paper flowers and by natural flowers in hermetically sealed glass tubes, seems to support Forel's view, but the whole matter is far from settled. Certain sensory cells on the palpi, in the mouth, and on the epipharynx are believed to function as *taste-buds*, but there is really no conclusive evidence that bees have any sense of taste. They are very sensitive to the vibrations of solid objects, and well-developed organs of *touch* are found in many parts of the body. Most practical beekeepers insist that bees *hear*, and communicate with each other by means of sounds. The two very different cries emitted by the queen, and the characteristic noises which accompany swarming, fighting and other activities would certainly lead the casual observer to agree with the beekeepers. The scientific investigators of the subject, however, who have conducted their experiments under controlled conditions in the laboratory, have failed to locate auditory organs, and report that the existence of a sense of hearing is doubtful.

The Organs of Reproduction.

The reproductive organs of the male or drone are those organs which produce semen containing *spermatozoa*, and convey it into the *vagina* of the female or queen. The spermatozoa are produced in the *testes*, two small flattened bodies in the front part of the abdomen. From the testes they pass through a coiled tube called the *vas deferens* into the *seminal vesicles*, where they remain until sexual intercourse occurs. The two vesicles communicate with the *penis*, which is ordinarily concealed within the abdomen, but is everted during copulation, and thrust into the vagina of the queen.

The eggs are produced in the *ovaries* of the female or queen; two ovaries are connected by means of *oviducts* with a single tube called the *vagina.* The lower end of the vagina is called the *bursa copulatrix*, and opens just below the base of the sting, on the eighth abdominal segment. When the countless spermatozoa are injected into this opening by the penis of the drone, they are stored in the *spermatheca*, where they may remain during the lifetime of the queen, as bees copulate only once. The spermatheca opens into the vagina, and it is in the vagina that the spermatozoa meet and fertilize the eggs as they come down from the ovaries.

CHAPTER III

GROWTH AND REPRODUCTION

The Queen.

An ordinary colony of bees, in the summertime, contains from five thousand to sixty thousand individuals, of three different types. In a colony of twenty-five thousand, let us say, there should be one *queen*, or true female and four or five hundred drones, or males, while all the rest are *workers*, or undeveloped females.

All of these bees hatch from eggs laid by one individual—the largest bee in the hive, conspicuous for its long and distended abdomen. Moving restlessly about the comb, it is often surrounded by a circle of smaller bees, who always face it, and touch its body gently with their antennae. The ancients called this large bee the *king*, and regarded its entourage as a kind of guard of honor. Later, when the king was discovered laying eggs, the royal title had to be altered. The *queen*, as a matter of fact, is in no sense the ruler of the colony. The only functioning female in the hive, she is a mere egg-laying machine, subject to the capricious tyranny of her attendants. She does not even feed herself, but is stuffed with honey

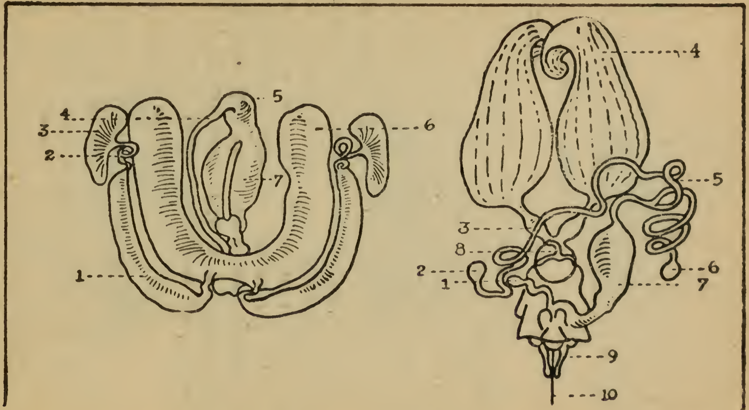

Fig. 4.—The Reproductive Systems. A, reproductive organs of drone: 1, semenal vesicle; 2, vas deferens; 3, testes; 4. ejaculatory duct; 5, penis; 6, accessory mucous gland; 7, bulb of penis. B, reproductive organs, sting, and poison glands of queens: 1, alkaline gland of sting 2, acid gland of sting; 3, oviduct; 4, ovaries; 5, duct of acid glands; 6, acid gland of sting; 7, poison-sac; 9, palpus of sting; 10, sting. (Adapted from Snodgrass.)

by the workers who accompany her on her egg-laying rounds; she leaves the hive only two or three times in her life, never gathers nectar or pollen, and takes no part in the ordinary activities of the colony, but gives her entire energy and attention to egg-laying.

The Myth of Royalty.

Literary beekeepers have not scrupled to revive the ancient myth of royalty; Maeterlinck declares that the worker bees around the queen "invariably arrange themselves so as to face her with eyes and antennae, and to walk backwards before her. It is a token of respect.... During the slight spasm that visibly accompanies the emission of an egg, one of her daughters will often throw her arms around her, and appear to be whispering to her, brow pressed to brow and mouth to mouth." Another old story was that there were always twelve of these obsequious attendants, and this number was somehow connected with the twelve apostles.

The Nuptial Flight.

Even the pleasures of sex are almost denied the queen, who often lives and lays eggs for three or four years, but copulates only once. When the queen is about a week old she comes out of the hive for the first time, to engage in her nuptial flight, for there is no sexual in-

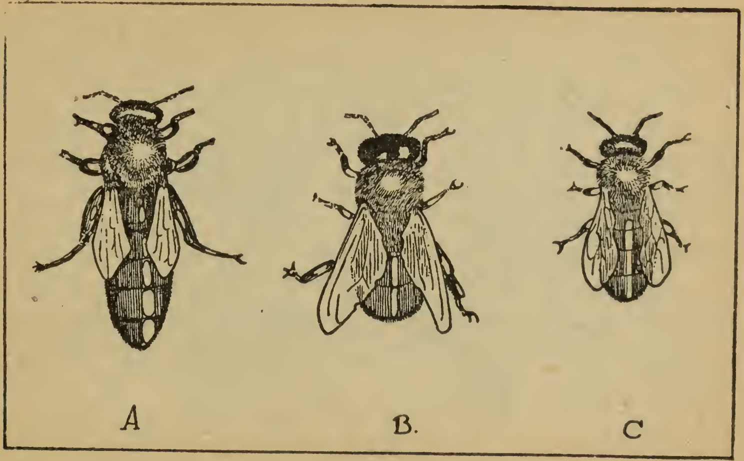

Fig. 5.—The three types of individuals. A, queen; B, drone; C, worker.

tercourse in the hive. After a little coquettish pirouetting about the entrance, she is off like a rocket, followed by every drone within sight, smell, or hearing. One of these gallants overtakes her, usually at a great height, and the sexual embrace lasts but a moment. The male is unable to extract his penis from the vagina of the queen, and the entire copulatory apparatus is torn out of his body, dragging with it the other abdominal organs, and killing him immediately. The queen returns to the hive with this whitish mass attached to her abdomen, or, to use one of Maeterlinck's luscious phrases, "she descends . . . trailing behind her, like an oriflamme, the unfolded entrails of her lover." The workers pull these organs out of the queen's body, and her brief love-life—lasting fifteen or twenty minutes at best—is at an end. The *spermatheca* in her abdomen is now filled with seminal fluid containing millions of spermatozoa, and this supply is sufficient to fertilize eggs for the rest of her life.

About the third or fourth day after mating, she begins the egg-laying which is her sole function in the community life. Passing rapidly over the brood-comb which the workers have prepared, she deposits a single egg in each cell, fastening it to the wax by means of a sticky secretion. The number of eggs laid by a single queen is astounding. Dr. E. F. Phillips, who

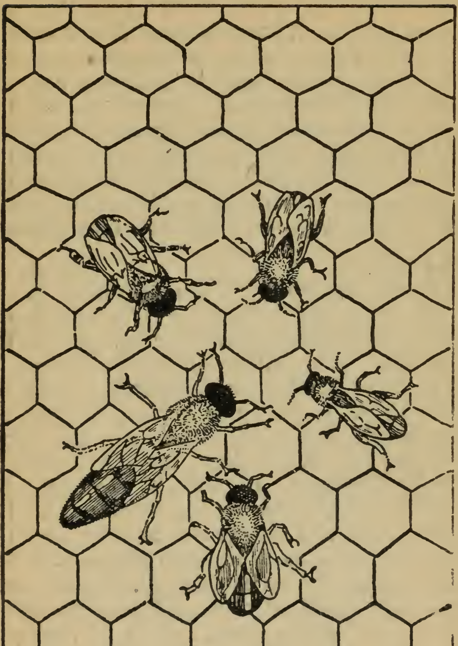

Fig. 6.—The queen and her retinue. Note that the surrounding workers face the queen.

has charge of the bee culture researches conducted by the United States Department of Agriculture says that some queens lay as many as five thousand eggs in a single day, and maintain this average for several days. Phillips is also responsible for the statement that "the weight of the maximum number that can be laid in a day is equal to about twice the weight of the queen at any time during the period, indicating a marvelous rapidity in metabolism."

Fratricide.

Of the hundreds of drones reared in the colony, only one actually renders any service, and he dies immediately after the labor of love is done. His fellows—honorary lovers, as Maeterlinck calls them—continue to buzz idly about the hive, getting in everybody's way, and consuming vast quantities of the stores gathered by the workers. At the end of the harvest, however, all this is changed. The workers attack the males, tearing off their wings, legs, and antennae; they do not sting them to death, as is commonly believed. The great clumsy drones can make little resistance; many are killed at once, and the rest driven out of the hive. Great crowds of these unfortunates may be seen crawling about just outside the entrance, but they are neither fed nor allowed to enter the hive, and all soon perish of hunger and cold.

The Egg.

The egg of the honey-bee is a pearly white, banana-shaped object, about one-sixteenth of an inch long, the smaller end being fastened to the base of the cell with a sticky substance secreted by the queen. The shell of the egg is a thin, tough membrane called *chorion*, which contains the nucleus, a little protoplasm, and a large amount of non-living food known as the yolk. About two days after the egg is laid a band-like thickening appears lengthwise of the convex side, and a row of rounded protuberances are seen upon this band, near the larger, unattached end of the egg. The first two of these swellings to appear develop into the mouth parts—the mandibles and maxillae Just behind these structures are the rudiments of the three pairs of legs, and a row of pits on either side represents the stigmata or breathing-holes. The beginnings of silk-glands are located just behind the maxillae, and the top of the head shows a swelling which may be recognized as a rudimentary brain. By the end of the second day most of the important parts of the body are represented, and some of them (the legs, for example) have disappeared, not to be seen again until the beginning of the pupa state, some six or seven days later.

The Growth of the Larva.

On the third day the egg-shell is broken and the young bee, now known as the *larva*, crawls out—a little white, soft, grub-like thing, with no eyes, no legs, no wings, no antennae—a creature very different indeed from the adult honey-bee. For three days the larva lies curled up in the bottom of the cell, and does nothing but eat the concentrated food which the workers bring to it. The nature of this food is unknown—we cannot say whether it is a secretion from certain special glands of the nurse bees, or is composed of partially digested nectar regurgitated from the stomach. After the first three days, when the larva has become large enough to lie lengthwise in the cell, it is fed upon honey and pollen. It is interesting to note that although the larva eats a great quantity of food, and increases its size perhaps fifty times during the first five days of its life, there is no provision for the disposal of waste matter—no movement of the bowels. While the stomach and intestines are well developed, there is no communication between them, so that defecation is quite impossible.

The Pupa

When the larva is full grown, which is, in the case of the worker, when it is about five days old, the attendant workers seal up the cell with a porous cover of wax, and the larva itself spins a flimsy cocoon of silk in the head

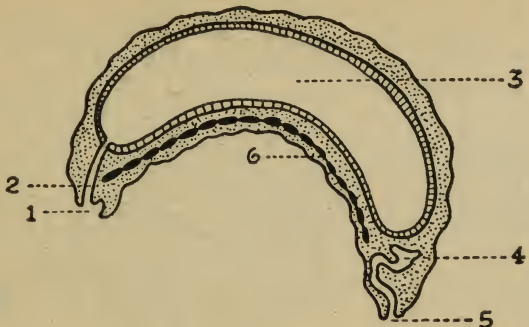

Fig. 7.—Cross Section of Larva. 1, mouth; 2, esophagus; 3, stomach; 4, intestine; 5, anus; 6, ventral nerve cord. Note that there is, at this stage, no connection between the stomach and the intestine, so that feces must be retained until the final moult.

end of the cell. On the third day after the sealing of the cell, the larva sheds its skin, and at the same time a rupture of the lower end of the stomach connects this organ with the intestine, so that the feces which have accumulated during the larval period are evacuated. This operation marks the end of the larval stage, which in the case of the worker lasts about six days. The last moult follows immediately, and the *pupa* appears with the form and all the parts of the adult bee, but very soft and white. Some three days later the large compound eyes turn pinkish, then brown, and on the seventh day become black. The thorax turns yellow, the wings and legs appear in their proper size and color, and finally, on the twelfth day after pupation the young worker gnaws through the wax cap and emerges from the cell.

The complete metamorphosis of a worker bee, from the deposition of the egg to the emergence of the adult, takes twenty-one days. In the case of the drone the pupal period is a little longer, running the total up to twenty-four days, while the queen's period of pupation takes only about seven days, so that her development is complete in sixteen days.

The Youth of the Worker

The newly emerged worker still wears the remnants of the pupa as a soft grayish cloak,

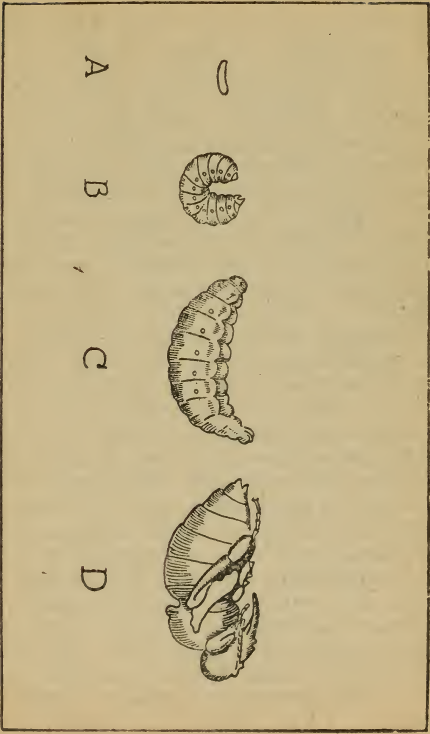

Fig. 8.—The Metamorphosis of the Worker. A, egg; B, young larva; C, full grown larva; D, pupa.

but as soon as this is removed the young bee looks very much like its elders, except that it is a little lighter in color. It does not leave the hive, however, for about a week, except in the case of swarming. Phillips thinks that this reluctance to venture out is due to the fact that the young bee is practically blind, and it is certainly true that the eyes of young workers are partially covered with fine hairs, which are not present in older bees. For the first few days they devote themselves to labor within the hive, such as feeding larvae, queens and drones. Sometimes they assist in comb-building, and they are always ready to fight off intruders or enemies of the colony. The first flight occurs when the young bees are about a week old, and then they merely circle about for a few minutes voiding their accumulated feces, and seldom venturing more than a few feet from the entrance of the hive. From this time forth they sally out on every bright day, the flights become more and more extended, and finally, about the seventeenth day, they begin the work of gathering food and water with their elders in the fields. The length of a bee's life varies inversely with the amount of work done; in the height of the summer season the worker wears itself out in two or three weeks, but bees hatched at the end of the honey-flow usually survive the winter.

The Virgin Birth

If the queen is somehow prevented from mating, she usually dies without issue, but sometimes she lays eggs, and occasionally the eggs hatch. This production of offspring without masculine assistance is called *parthenogenesis*, or virgin birth. These unfertilized eggs, however, always produce drones, that is, male bees. It has been noted also that very old queens, in which the supply of spermatozoa is presumably nearing exhaustion, lay an ever-increasing number of drone eggs. Another important observation is that sometimes, when a colony is left queenless, workers (which are quite incapable of sexual intercourse) have been known to lay eggs. These worker's eggs, if they hatch at all, always produce drones.

In 1845 a German beekeeper named Dzierzon, who had given these matters considerable attention, published the conclusion that all drones are produced parthenogenetically, whether the mother has been mated or not, and that fertilized eggs always produce females—that is, workers, and under certain conditions, queens. This theory raised a storm of criticism at the time, but is now pretty generally accepted everywhere. It is important for the practical beekeeper to know that he can always improve his stock by buying pure-bred queens, even if they do mate with inferior drones, because *drones have no father*, and therefore are always pure-bred if the laying queen is. The further conclusion is sometimes drawn from the data of parthenogenetic development that the queen can "voluntarily" withhold or allow fertilization; Dzierzon himself said flatly that the queen was able "at pleasure" to lay either worker or drone eggs. This view is not based upon observation or experiment, and has no foundation in fact; there is not a scrap of evidence to show that bees are anything more than extraordinarily complicated machines, entirely without conscious or volitional motivation.

The Royal Jelly

We have seen that the queen lays two kinds of eggs, fertilized and unfertilized, and that workers are hatched from the former, while the latter always produce drones, but the production of queens has still to be explained. Queens hatch from fertilized eggs, identical in every respect with those which produce workers. The young larvae are also identical—no one can tell by examining a newly hatched larva whether it will develop into a worker or into a queen. Its future depends, apparently, upon two factors: first, the nature of the cell in which it is cradled, and second, the sort of food with which it is supplied. If it is left in an ordinary brood-cell, and fed upon a milky substance (probably composed of partly digested pollen and honey) it becomes a worker; if it is reared in a large, acorn-shaped chamber called a *queen cell*, and fed upon a creamy, rank substance known as *royal jelly*, it develops into a queen.

Swarms and After-Swarms

When a colony of bees becomes excessively strong or crowded it divides into two parties, one of which remains in the old hive, while the other sets out to take up a residence elsewhere. The division which leaves the old home is known as a *swarm*, and the whole adventure is called *swarming*. The first step toward swarming is the rearing of a second queen, and the beekeeper knows that swarming is imminent when he sees the peanut-like queen cells on the combs. When the larva in the queen-cell is fully developed the cell is sealed up with wax, and, this done, a most striking and exciting thing occurs. The bees rush crazily out of the hive, circling and careering about in a wild, drunken manner, and humming and buzzing in a peculiar fashion—the "swarm tone", once heard is unmistakable. Each bee has its body distended with honey taken from the combs, enough to last for several days. Swarming bees very rarely sting, and it is popularly supposed that they cannot use their stings because their abdomens are so full of honey but this belief is without foundation.

If the queen is somehow prevented from accompanying the flight (and beekeepers often accomplish this by clipping her wings) the swarming workers soon quiet down and return to the hive, but if the queen is with them they settle in a dense cluster on the limb of a tree or some similar support. If the beekeeper is at hand he houses the swarm in a hive which he has provided for the purpose; if this is not done the bees, after resting for an hour or so, fly away to a new home of their own choosing—usually a hollow tree located by scouts several days before. Arriving at the spot selected, the first bees to locate the entrance stand before it, their legs extended, wings fanning, and abdomen raised. Bees in this position exude a peculiar odor from a scent-organ on the dorsal side of the abdomen, between the sixth and seventh terga, and this odor is always present when they are entering a new home. Once started in the right direction, the bees march into the cavity, carry out all loose pieces of bark and dirt, and smooth down all irregularities as best they can. The next duty is the building of the comb, and a living curtain of wax-workers is soon suspended from the ceiling. As soon as the first comb is in position the field bees begin to store nectar and pollen, the queen proceeds with the egg-laying, and everything is ordered exactly as it was in the old hive.

Meanwhile, in the colony from which the swarm proceeded, there is more or less confusion. The old queen, the mother of them all, has gone, together with perhaps one-half of the population, and the entire menage is considerably disorganized. In a few days, however, a young queen emerges from one of the queen-cells, is fed a little honey, and immediately raises her voice in a sort of piping—*z-e-e-p, zeep, zeep*. The unhatched queens in the other cells answer with a cry best rendered as *quahk, quahk*,—a sound difficult to describe, but which, once heard, is unmistakable. This *quahking* sound is emitted only by young queens before they come out of the queen-cells. The first queen to emerge nearly always tries to tear open the other cells, and murder her young sisters. Sometimes the workers permit her to do this, and even assist in the destruction; at other times, however, for some reason as yet unknown, a strong guard of workers is thrown around each cell, and the first queen to emerge is not allowed to destroy the others. In this case the virgin queen leaves the hive with a swarm, usually much smaller than the first one—these later swarms are known as *after-swarms*. The issuance of after-swarm cannot always be predicted or prevented; they sometimes emerge without any queen at all, or fly away to the woods without clustering, and are a source of continual annoyance to the beekeeper.

The Robbers

Bees are able (probably by the sense of smell) to recognize the members of their own colony, and ordinarily no outsiders are permitted to enter the hive. Sometimes, however, by reason of the loss of the queen and the consequent dearth of young workers, a colony becomes too weak to defend its stores. Should this happen at a time when there is no nectar to be found in the fields, idle worker bees from neighboring hives gather about the weak colony, and attack the sentinels at the entrance. The aged guardians fight as best they can, tearing off heads, legs and wings, until the ground about the entrance is strewn with the dead and dying. If the home guards are hopelessly outnumbered they give up the struggle at last, allowing the robbers to loot the combs and carry off the honey to their respective hives, leaving their defeated neighbors to die of starvation, or to join the victorious colony. This robbing is a very serious matter to the beekeeper, for weak swarms are often entirely cleaned out, and thousands of bees killed in battle. Besides, if bees once get the robbing habit, they follow the beekeeper as he goes about his work, rushing into every hive that is opened, and creating an uproar which disorganizes the entire apiary.

CHAPTER IV

THE WORKER'S TOIL

Since the queen and the drones devote their entire time and attention to reproduction, the labor of the colony is done solely by the workers. The building of honeycomb is one of the most important functions of mature workers, because very young or very old bees do not secrete wax readily. The worker bee has eight plates on the lower side of its abdomen, and the glands in these plates secrete a liquid which hardens into wax when it comes in contact with the air. This wax forms the white, pear-shaped wax-scales which are seen fastened to the abdomens of bees engaged in comb-building, and are often found lying about on the floor of the hive. By appropriate movements of the legs the wax-scales are brought forward to the mandibles, where the wax is masticated and mixed with saliva until it is in the proper condition to be worked into the comb. The comb-builders, crawling over one another, and clinging to each other's legs, cluster together to form a kind of dense festoon, suspended in the place where the new comb is to be situated. The bees at the top commence the work by attaching little masses of wax to the support, others follow their example, and thus the foundation of the comb is laid, from which the layers of cells grow out downwards and sideways. The blanket of bees keeps the whole structure at such a high temperature that the wax remains soft and workable, and it is constantly being tinkered. No one worker ever builds a cell complete; each seems to run aimlessly about, putting on a little wax here, pinching off a bit there, and twisting and pulling at each other's work in an apparently confused and unworkmanlike fashion. Very often, after one bee has painstakingly adjusted a large piece of wax, another rushes in and twists it all awry, but somehow the comb always seems to turn out surprisingly well.

Three Sorts of Cells

The cells are not all of the same size and shape—there are three distinct kinds. Perhaps four-fifths of the comb is made up of worker cells, which are about one-fifth of an inch in diameter. Drone cells, which measure about one-fourth of an inch across, are much less numerous, while queen cells, very much larger, are very exceptional, only half-a-dozen perhaps being built in the course of a season. When the large drone cells are not occupied by immature drones they are used for storing honey, while unused worker cells are often filled with pollen. The typical drone or worker cell is a hexagonal tube, and the comb is formed of two layers of these, with their bases together. The cells are usually a little inclined, the outer ends being slightly higher than the inner; this arrangement prevents the honey from running out during the maturation period, when the cells are not yet sealed or capped. Contrary to popular opinion, bees build comb for their immediate needs, with apparently no thought for the future. At the beginning of the season, if the queen is laying well, they build worker cells; if the queen is a poor layer, or the colony is very weak, they build mostly storage cells, drone size; if the queen is lost they build nothing but storage cells, regardless of the future interests of the colony.

Bee Mathematics

The combs in a natural nest are jumbled together in a hopeless confusion, and even in the modern moveable-frame hive, where every precaution is taken to prevent it, a good deal of crooked comb is produced. The uniformity of size in the cells has been enormously overstated; at the time when the decimal system of measurement was established in France, a man named Réaumur even proposed that the diameter of a cell be adopted as a legal unit, upon which the whole system should be based. The engineering ability of bees has also been grossly exaggerated by mathematicians, poets,

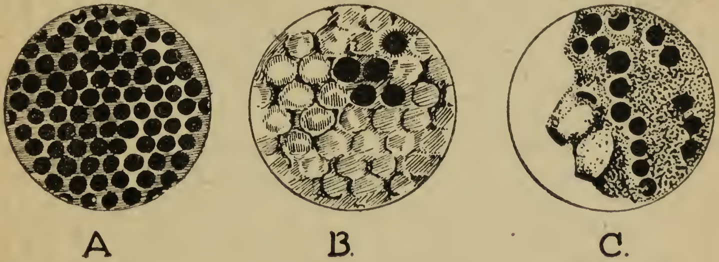

Fig. 9.—The Three Sorts of Cells. A, typical worker cells, newly made and as yet uncapped. B, brood cells, capped. Those with the large protruding caps contain drone larvae. C, queen cells.

and other people who knew nothing in particular about the subject. The following quotation from Reid is a good example of this sort of thing: "There are only three possible figures of the cells which can make them all equal and similar, without any useless interstices. These are the equilateral triangle, the square, and the regular hexagon. Mathematicians know that there is not a fourth way possible in which a plane can be cut into little spaces that shall be equal, similar, and regular, without useless spaces. Of the three figures, the hexagon is the most proper for convenience and strength. Bees, as if they knew this, make their cells regular hexagons.... Again, it has been demonstrated that, by making the bottoms of the cells to consist of three planes meeting in a point, there is a saving of material and labor in no way inconsiderable. The bees, as if acquainted with these principles of solid goemetry, follow them most accurately. It is a curious mathematical problem at what precise angle the three planes which compose the bottom of a cell ought to meet, in order to make the greatest possible saving, or the least expense of material and labor. This is one of the problems which belong to the higher parts of mathematics. It has accordingly been resolved by some mathematicians, particularly by the ingenious Maclaurin, by a fluctionary calculation which is to be found in the Transactions of the Royal Society of London. He has determined precisely the angle required, and he found, by the most exact mensuration the subject would admit, that it is the very angle in which the three planes at the bottom of the cell of a honey comb do actually meet."

However, the work of many experimenters, among whom may be mentioned Charles Darwin, indicates that the whole thing is purely mechanical; the cells are probably circular at first, and are subsequently converted into hexagons by the pressure of surrounding cells.

As Buffon long ago pointed out: "If you fill a dish with peas or any other cylindrical bean, pour as much water into it as the space between the beans will allow, close it carefully, and then boil the water, you will find that all these cylinders have become six-sided columns. And the reason is evident, being indeed purely mechanical; each of the cylindrical beans tends, as it swells, to occupy the utmost possible space within a given space; wherefore it follows that the reciprocal compression compels them all to become hexagonal. Similarly each bee seeks to occupy the utmost possible space within a given space, with the necessary result that, its body being cylindrical, the cells become hexagonal for the same reason as before, viz., the working of reciprocal obstacles." Similar phenomena have been noted in the formation of frost crystals, the drying of mud in roadside pools, the bubbles in bottled beer, and the scales of certain kinds of fish.

The Labor in the Fields

Worker bees go into the field to obtain four substances: nectar, pollen, propolis, and water. Nectar is a sweet liquid secreted in the flowers of many species of plants. It is gathered by the older workers and carried in the crop or honey-stomach to the hive, where it is regurgitated and stored in the cells of the comb. These cells are left uncapped for a week or so while the contents are ripening into edible honey, and are then sealed over with wax. The sweet taste of nectar is due to the presence of *sucrose* or cane sugar, but the sugar found in ripened honey is mainly *dextrose* or grape sugar. The change is brought about by the action of an enzyme or ferment in the salvia of the bee. Honey contains a little acid, but the old story that the bee puts a drop of formic acid from the sting into each cell of honey, to act as a preservative, seems to have no foundation in fact.

Ordinary honey, then, is simply the partially dehydrated nectar from flowers, plus certain ferments or enzymes added by the bees. Sometimes, however, bees gather what is known as *honey dew*, a sweet liquid found upon the leaves of certain trees. Pliny and other ancient naturalists supposed that honey-dew fell from Heaven, but modern investigation has shown that its real origin is by no means celestial. Plant-lice, and various other insects which feed upon the sap of plants, digest and assimilate only a small part of their food; the rest is excreted as waste matter, and appears upon the leaves as honey-dew. At times this sweetish "louse-urine" is so abundant that it drips from the trees like rain. The better grade of honey-dew honey from plant-lice is clear, sweet, and not at all unpalatable; many Westerners, indeed, prefer it to the best floral honey.

Pollen, another food which bees gather from flowers, is usually in the form of a fine yellow powder; it is not taken into the crop as nectar is, but carried in the *corbiculae* or pollen-baskets on the hind legs. While the bee is at work on the flower, pollen is scooped up by the mandibles and tongue, and also adheres to the hairy parts of the body, whence it is collected by the pollen-brushes on the legs, and packed into the corbiculae. The pollen is probably moistened a little with nectar from the mouth of the bee, and Casteel, in one of the U. S. Bureau of Entomology publications, presented analyses showing that honey is often found mixed with the pollen in the pollen-baskets. Once in the hive, the pollen is usually stored in unused worker cells, where it remains until needed as food. This stored pollen is known as bee-bread. Sometimes, when there is a dearth of natural pollen, bees will carry sawdust, or meal, or even the black dust from coal mines. Many beekeepers feed a little rye flour or corn meal to the bees in the spring, believing that this procedure saves time which would otherwise be spent in the fruitless search for pollen, and prevents the retardation of brood rearing.

Propolis is a mixture of gums and resins collected from various plants, and is used in coating the inside of the hive, filling cracks and crevices, and strengthening the honey-comb. It is said that bees always varnish the inside of brood-cells with propolis, but this statement has not been authenticated. In the absence of natural propolis, bees will often carry off any kind of paint or varnish, and the old story, still current in backwoods districts, that bees always follow their owner to the grave, probably sprang from the fact that bees were seen working on the varnish of some home-made coffin. Propolis is gathered in the mandibles, and carried in the pollen-baskets; it is never stored in cells as pollen is, but is always applied immediately to the place where it is to be used.

In the early spring and summer bees may be seen congregating about some creek or pond gathering water, which they carry in the crop just as they do nectar. The amount of water required by a colony depends upon the amount of brood being reared, and upon the nature of the food used. If bees are being fed with thick syrup or candied honey they need a great deal of water, while if they are getting thin raw nectar from the fields they require very little beyond that contained in the food.

Feeding the Hungry

Besides building honeycomb, and gathering food and water in the field, the worker bees feed the larvae, the drones and the queen. The feeding of larvae is a process about which very little is known, but this much is certain: the larvae are fed by workers, and the food is a milky-white paste with a strong acid reaction. The source of this substance is a matter of considerable controversy; Schiemenz, Cheshire and others think that it is produced by certain glands in the worker's head, while Schonfeld, Cook and Cowan contend that it is a mixture of partially digested nectar and pollen regurgitated from the stomach. Those who incline to the first view point out that the contents of the worker's stomach always appears as a sort of dark-brown slime, altogether different from the white paste fed to young larvae. The adherents of the theory that the larval food comes from the stomach have shown that when workers are fed with powdered charcoal they produce black brood food, and regard this fact as proof positive that the ventriculus, or stomach, is the source of this food. Snodgrass and others reply that this proves nothing, because the charcoal may have been retained in the mouth, esophagus, or crop—and thus the wrangle goes. The whole question remains open, and can be settled only by painstaking objective investigation. The so-called royal jelly with which the queen larva is fed, is very similar in composition to the food given ordinary larvae. Adult queens and drones have been seen to take honey from the cells, but they do not ordinarily do this, but are regularly fed both honey and pollen by the workers. If larvae, drones or queens are injured or abnormal in any way they are not fed at all but are thrown immediately out of the hive, for bees have no time to fuss with cripples.

House-Cleaning and Ventilation

Another task which the workers perform is the cleaning of the hive. Every bit of debris or foreign matter is removed; dead bees or larvae are carried out, while objects too heavy to be moved (such as mice, lizards or other intruders which have been stung to death) are carefully sealed up in a coating of propolis and left where they fell. The ventilation of the hive is accomplished by workers which station themselves at favorable points and fan the air with their wings, creating a draft which protects the colony from suffocation, and from excessive moisture and temperature.

Home Defense

The protection of the colony against robbery or disturbance is another function of worker bees, some of which are always stationed about the entrance of the hive, ready to attack any intruder. Bees in the field are busy with their work, and usually avoid any disturbing object, but those which serve as guards at the door of the hive are belligerent in the extreme, and will attack anything from an ant to an elephant which threatens the colony. One has only to shake the hive a little, and thousands of workers rush out and plunge their stings into any moving object which presents itself. A single sting is merely a slight prick, followed, in the case of persons not immunized by previous experience, by a painful swelling due to poison injected into the wound. When a great nummer of stings are received at once, however, the poison becomes a serious matter, and cases are on record where cats, dogs, babies, and even horses have been stung to death.

CHAPTER V

ENEMIES AND DISEASE

Foul Brood

Bee larvae are subject to three distinct and recognizable infectious diseases, designated as American foul brood, European foul brood, and pickled brood. These ailments never attack adult bees, and they are not due to hunger, cold, or "sour honey"; they are caused by the activity of micro-organisms, similar to the disease germs which afflict the human species.

American foul brood attacks the mature larvae, usually after the cells have been capped over. Hundreds of the larvae die, and shrivel into dark, sticky, tenacious scales—the "ropy" consistency of the dead brood is characteristic of this particular disease. The capping, if it is not removed by the workers, sinks a little, and gives the foul-brood comb a characteristic appearance. Soon the whole hive stinks like a glue-pot. As the diseased colony becomes weaker by reason of the loss of brood, it is set upon by robbers who distribute the infected honey to their respective hives. and thus the plague spreads throughout the entire apiary.

European foul brood differs from the American variety in that it attacks unsealed brood, and spreads very much more rapidly.

The dead larvae do not become "ropy," and the offensive odor so characteristic of American foul brood is not much in evidence. American foul brood attacks all races of bees indiscriminately, but the Italians seem to have developed a partial immunity to the ravages of the European disease.

Pickled Brood

Pickled brood or sacbrood is much less serious than the other brood diseases. It usually develops among mature larvae, but the dead matter is never "ropy" or tenacious as in the American foul brood, and the disease does not spread with the deadly rapidity of the European variety. Sacbrood is infectious, but the organism which causes it has never been isolated and described.

Bee Paralysis

Bee paralysis is common enough in the Southern and Southwestern states, where it affects whole apiaries and seems to be contagious, although the infecting agent has never been discovered. It attacks adult bees only, and the diseased individuals are seen trembling and wabbling about the entrance of the hive, dragging their swollen abdomens. These unfortunates soon become practically helpless, and are thrown out of the hive by their stronger sisters. Bees are indefatigable in the labor of gathering honey and raising brood, but they have no time to fuss with cripples or invalids. A particularly deadly sort of paralysis, which seems to have originated in the Isle of Wight, has done a great deal of damage in Great Britain. This "Isle of Wight disease," as it is called, is much more serious than any bee disease known in America, and there is no remedy except the destruction of the colony to check the spread of the infection. A German scientist named Zander has discovered a protozoon parasite in the stomachs of these paralysed bees, which is believed by many to be the cause of the malady. What is said to be a mild form of the Isle of Wight disease has recently appeared in Oregon, but has done little damage so far.

Four-footed Foes

Bears eat both bees and honey with great relish, and in the early days of American bee-keeping these animals were the apiarist's most formidable foes, breaking open his "bee-gums" and wrecking whole apiaries in a single night. At present, however, bears in America are so few and far between that their depredations are insignificant.

Skunks frequently visit bee-yards at night, and by scratching about the entrance cause many bees to rush out upon the alighting board. These are eaten with every symptom of satisfaction—the skunk seeming quite impervious to stings. Besides killing a great many bees, these nocturnal marauders leave the colony in a state of perturbation which lasts for several hours, and interferes with the routine duties of the following day.

A mouse could never enter a beehive in the summer-time, but in winter when the bees are cold and inactive, mice sometimes gnaw into the combs and do incalculable injury to the dormant colony. In some localities it is necessary to cover the entrance with wire netting, just coarse enough to admit the bees, and fine enough to exclude mice.

Several species of lizards have been seen to go into the beehives, particularly in the Southern states, but it is by no means certain that they eat bees, or do any particular dam age. It has even been said that lizards are a benefit to the colony, in that they destroy the wax-moths which are a real menace in some localities.

Birds

Bee-martins and other birds of the fly-catcher type sometimes prey upon bees. Every experienced beekeeper knows this to be a fact, but it has been denied by some bird-lovers, who shot a large number of bee-martins and failed to find any bee remains in their stomachs. Further investigation shows, however, that these birds do not swallow bees at all, but merely crush them in the beak for the sake of the honey, and drop the emptied body to the ground. If the birds confined their attention to workers and drones there would be little harm done, but the loss of a virgin queen on her wedding journey is a serious business.

Insects and Their Allies

Spiders often build webs about the apiary and catch a few bees, but they also destroy wax-moths, and probably do less harm than good. Robber-flies, wasps, and hornets carry off a bee occasionally, but are not regarded as serious enemies. Dragonflies, known also as bee-hawks and devil's darning-needles, are very destructive sometimes, particularly in the South. The A. I. Root apiary in Florida was damaged to the extent of a thousand dollars in four or five days, and the owners were finally compelled to ship four hundred colonies north to save them from these voracious insects.

The Italian bee-louse (*Braula coeca*) is the only bee parasite known, and it is not common in America, being found chiefly upon recently imported queens. J. Perez, writing in one of the French bee journals, tells a good story about this pest:

> "One day, having captured a bee with one of these lice I fixed its head with a pair of pincers sufficiently to keep it immovable, and to capture the small parasite easily. Both it and the bee were left for a while on the table in my studio, under a glass.
>
> "When I returned to them I was not a little puzzled to see the parasite in the most vivacious and strange agitation. Seated on

the fore part of the bee's head it was moving about with incredible vivacity, as though possessed of veritable rage. Now it would go to the margin of the bee's cap, with its fore feet raised, stamp and scratch as hard as its weakness would allow at the base of the bee's lip; then it would suddenly run back to the insertion of the antennae to renew its impetuous attack immediately. I was quite taken up by my first surprise, when I suddenly saw all this fury turned to perfect calmness, and the little animal squatted on the edge of the cap and bent down its head to the bee's mouth, which was slightly trembling, and sucked up a drop of moisture.

"I instantly understood. The movements I had just witnessed were preparatory to the animal's meals. When the louse wishes to feed it goes to the bee's mouth, where the motions of its feet, armed with bent claws, produces a tickling sensation, perhaps disagreeable to its host, but at least provoking some movement of the buccal organs, which slightly open and release a small drop of honey which the louse at once licks up.

"Thus the *Braula coeca* is not a real parasite of the bee in the true sense of the word. It is rather a guest—queer, if you like thus to consider it, like so many others existing among animals."

Two species of wax-moths, or "moth-millers," are usually listed among the enemies of bees. The adult moths, of course, do not attack bees, but they slip into queenless or disease-ridden colonies and deposit their eggs along the edges of the frames. When the wax-moth larvae hatch they burrow at once into the comb, tearing down cells, eating pollen and cocoons, and leaving a trail of webs and excreta behind them. A few of these wax-worms may ruin a large amount of honey-comb in a very short time. The female moths may be seen flitting about weak colonies at twilight, seeking an opportunity to enter and deposit their eggs. For some reason or other the black or German bee seems less able to cope with these pests than the Italians, and a fairly strong colony of black bees will sometimes allow moths to reproduce in such numbers that all brood-rearing is out of the question, and the colony is soon wiped out entirely.

Ants are such a serious menace in Hawaii that the native beekeepers set up their hives on posts, with a strip of tanglefoot adjusted in such a way as to prevent the ants from reaching the colony. In the northern part of the United States ants are not taken very seriously, but they do considerable damage in some of the southern states. O. O. Poppleton describes the situation in Florida:

"With one exception these ants are the worst enemies bees have here in Florida, and only constant vigilance from September to December inclusive will prevent the loss of many colonies every season. These ants are usually found in our hummock lands, and only occasionally in clean pine woods; are red in color; of a very large size; frequently measuring nearly or quite half an inch in length; are strictly nocturnal in their habits, being seldom seen in daytime except when disturbed or waging battle with a colony of bees; are usually found in decayed wood, through which they eat out galleries for use as living apartments. A favorite place is in a saw-palmetto root in the ground. Nearly every cabbage-palmetto tree contains a colony of them among the roots near their top, and for this reason a thick palmetto grove is one of the worst places where an apiary can be located. They are also found in piles of old boards, and on the ground under boards or logs. They also like to enter our houses and locate in trunks, boxes, drawers, and in almost any place where they can find a few inches of space to occupy. They are frequently found in the tops of our hives, if there is sufficient space above the bees under the cover.

"At sundown they start on their nightly quest for food; and if near an apiary a few of them will usually be seen running on some of the hives. As long as only two or three can be seen on any one hive, no special attention need be given them; but if a dozen or more are seen, it means that they have probably selected that hive for their own use, and it needs close watching. They will continue their regular attentions to that one hive, gradually increasing in numbers until they decide they are strong enough, when nearly the entire colony of ants will boldly attack the bees by biting off their wings and legs, and crippling them so they are of no more use. Bees fight back courageously, the battle continuing for hours, and sometimes a day or two, according to the relative strength of the two belligerents. The inside of the hive and the ground near by will be strewn with dead ants and dead and crippled bees; but it always ends with the destrüction of all the bees, and the moving in and occupation of the hive by the ant colony. When the ants have once chosen a certain colony of bees to work on, the bee-master has to destroy the ants, root and branch, or they will in time destroy the bees. If a part only of the ants are destroyed, they will simply bide their time until they have built up strong enough, and then do the work. I know of few or no living creatures more persistent in evil works than are these bee-killing ants."

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BLUE BOOKS
READ THE WORLD OVER